(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 643 440 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94203444.8**

(22) Date of filing: **03.06.92**

This application was filed on 28 - 11 - 1994 as a divisional application to the application mentioned under INID code 60.

(30) Priority: **12.06.91 GB 9112604**
05.07.91 GB 9115020

(43) Date of publication of application:
15.03.95 Bulletin 95/11

(60) Publication number of the earlier application in accordance with Art.76 EPC: **0 588 834**

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU MC NL SE

(51) Int. Cl.[6]: **H01R 4/24**, H01R 9/24

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(54) Electrical connectors.

(57) An insulation displacement contact comprises first and second contact portions each of which comprises a cantilevered split beam. The upper split beam, which receives insulated wires, comprises a pair of tynes which are folded about the axis of a slot separating the tynes such that the internal angle between the tynes is approximately 90°. The width of the tynes is larger than that of prior art devices resulting in increased stiffness and the length of the tynes is sufficiently long to receive two wires therebetween.

The contacts are mounted in a housing which includes a plurality of teeth provided with means for retaining lugs on the end of the tynes to ensure bowed opening of the tynes on insertion of a wire. The contacts are arranged along the central axis of the housing such that the folded tynes of alternate contacts extend on opposite sides of the central axis.

Fig.1

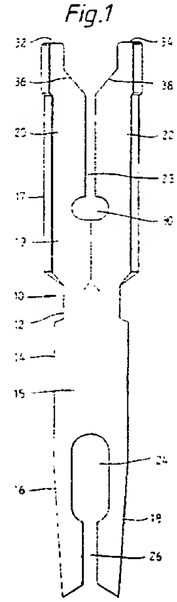

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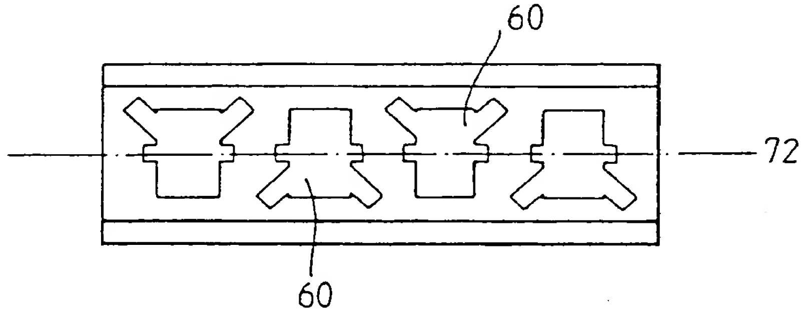
Fig. 6



This invention relates to electrical connectors and in particular to insulation displacement connectors for housing insulation displacement contacts.

Insulation displacement contacts are of particular applicability to the voice and data communications industry. There have been many proposals for insulation displacement contacts (IDC) in the past. However, all prior proposals suffer from one or more of a number of disadvantages as will be described.

The basic function of a connector block is to house a number of insulation displacement contacts, normally 4 or 8. The individual contacts provide at one end a pair of contacts for attachment either to a wiring block or to individual wires and at the other end a pair of contacts for receiving an insulated wire. The contacts are disposed in a manner which ensures that the insulation around the wire is stripped away or displaced as the wire is fed between the contacts. Commonly, this has been achieved by a cantilevered split beam where the two beam halves are displaced by a distance less than the width of the insulation of the wire with which the connector is to be used. The open ends of the beams are usually shaped so that the wire can be guided between the beam halves or tynes and a slot or opening is provided to retain the wire, with its insulation displaced, in contact with the connector and to give the tynes a degree of flexibility.

US4964812 (Siemon) discloses an IDC which comprises two opposed cantilevered beams each of which comprises a pair of tynes and each of which extends from a central portion. Each tyne pair is separated by an elongate opening along a part of its length and is formed from an original cantilevered beam by shearing along a shear axis which forms the cutting surface for cutting the insulation on a wire. The shear axis is conveniently the longitudinal axis of the cantilevered beam. This shearing produces a closed gap between the tynes of a beam. However, a secondary closing action is necessary to achieve a satisfactorily small gap between the tynes. This is achieved by a coining operation performed on the outside edges at the base of the tynes and decreased coin surfaces preload the beam elements whilst maintaining clean contact surfaces and raising the contact force to a level where it is sufficient to penetrate the insulation on small wires.

The need for a secondary operation to close the slot to the required dimension is undesirable and arises from an attempt to overcome problems with beam stiffness by increasing contact thickness.

The performance of a split beam contact is determined by the stiffness of the beam, which is itself proportional to the cube of the contact width in the direction of flexing. The requirement for contact stiffness is in direct conflict with the requirement that the IDCs have the smallest possible pitch so as to minimise instalation space and connector block width.

The solution proposed in US4964812 requires the secondary closing operation because the beam stiffness problem has been overcome by increasing contact thickness rather than width. The result is an IDC which is difficult to manufacture.

A similar approach has been taken by A T & T corporation in their 110 series connectors, for example the 110C-4. The displacement contacts are described in a number of US patents, for example US3611264 (Ellis), US3798587 (Ellis) and US4118095 (Berglund).

The contacts described in all these documents suffer from the same problems as the Siemon patent due to the attempt to solve beam stiffness problems by increasing contact thickness.

It has been proposed to overcome the requirements of a stiff beam and a narrow contact by producing a wide beam and rotating it in the connecting block by an angle of 45° to the central block axis. However, this approach still requires that a narrow slot is produced between the tynes, requiring a secondary closing operation and necessitating a wider moulding than the A T & T or Siemon solutions.

US4295703 (Northern Telecom) proposes a solution in which the gap between tynes is wide and the contacts are arranged in staggered rows. Although this alleviates the problems of closed gap connectors such as the A T & T and Siemon connectors it has the disadvantage that it requires a complex wire insertion tool to feed wires between the tynes and also a connecting block which must be made wider than is desirable to accommodate two rows of contacts.

A problem encountered with connector blocks which house insulation displacement contacts is end wall thickness. As the blocks usually house four or eight contacts it is usual to arrange a number of blocks side by side along a wiring block. The wiring block has a plurality of IDC receptors which are spaced apart evenly. End walls of adjacent connector blocks which abut one another tend to have a combined thickness which is too great for the spacing between the receptors on the wiring block.

Merely reducing the thickness of the end walls can lead to a structure which is too weak. US 4964812 mentioned previously overcomes the problem by using free floating insulation displacement contacts and by displacing the end contacts away from the end wall by about 0.005 inches (0.0127 cm). This enables the thickness of the end wall to be increased by about 30% and reduces

end wall breakages. However, it does have the problem that it relies on very high manufacturing tolerances and on the use of free floating contacts.

GB-A-2112217 (Broomadit Limited) discloses a system in which the tynes are folded around a central axis. The tynes are held firmly in place in the housing.

The present invention aims to provide an improved insulation displacement connector.

According to the invention there is provided an insulation displacement connector comprising a plurality of insulation displacement contacts, and a housing, the contacts being received in shaped apertures in the housing and comprising first and second contact portions, the second contact portions being arranged to receive insulated wires and comprising a cantilevered beam split into first and second tynes by a slot extending along an axis of the beam, at least one tyne being folded about the slot axis, the shaped apertures in the housing being arranged along a central axis of the housing to receive the contacts with the folded at least one tyne of successive contacts extending alternately on opposite sides of the central axis.

A connector embodying the invention has the advantage that the contacts can be pitched close together so minimising the size of the connector.

Preferably the end walls of the connector block are reduced in thickness on the side of the central longitudinal axis opposite to that on which the tynes of the insulation displacement contact adjacent the respective end wall extend.

Preferably the reduced thickness end walls have a stepped configuration whereby adjacent connector blocks may be arranged along a wiring block without having to weaken the end walls.

The combination of reduced end wall portions and contacts disposed on alternate sides of the central axis eliminates the need for irregularly spaced floating contacts whilst retaining the advantages of having sufficiently thick end walls. As the preferred arrangement of the contacts in the block retains the free ends to provide a barrel shaped opening of the tynes of the contacts the solution in US 4964812 is not suitable.

Thus, the preferred arrangement maintains a high end wall strength without changing contact pitch and whilst allowing the connector to be continuously end stackable.

An embodiment of the invention will now be described, by way of example, and with reference to the accompanying drawings in which:

Figure 1 is a front elevation of an insulation displacement contact embodying the invention claimed in our co-pending parent application EP-A-588834 out of which this application is divided;

Figure 2 is a top view of the contact of Figure 1;

Figure 3 is a part perspective view of the upper part of the contact of Figure 1;

Figure 3a) and 3b) are, respectively, plan and front views of a schematic contact illustrating the mode of opening.

Figure 4 is a side view of a housing for the contact of Figures 1 to 3 and embodying the invention.

Figure 5 is a view on the line V-V in Figure 4;

Figure 6 is a view from below of the housing of Figure 4;

Figure 7 is a view similar to Figure 6 of an alternative housing;

Figure 8 shows how successive housings may be end-stacked; and

Figure 9 is a perspective view of a housing adapted for use with two or more different wire insertion tools.

The insulation displacement contact (IDC) 10 of Figures 1 to 3 comprises a central waisted portion 12, a lower contact 14 comprising a first cantilevered beam 15 having a pair of tynes 16 and 18 and an upper portion 17 comprising a second cantilevered split beam 19 having tynes 20 and 22.

The lower contact is intended to contact the IDC to a terminal of a wiring block (not shown) to establish electrical contact between the wiring block and one or more insulated electrical wires inserted into the upper portion in a manner to be described. An aperture 24 is formed between the tynes 16 and 18 at the base of the beam 15. The aperture extends over approximately half the length of the tynes. Over the other half the tynes are separated by a slot 26. The outer sides of the tynes are tapered so that the width of the beam reduces towards its free end to facilitate insertion into the wiring block terminal.

The upper cantilevered split-beam 19 comprises the two tynes 20, 22 which are folded about the axis of slot 28. In the example shown in Figures 1 to 3 the internal folded angle is approximately 90°.

Although this angle is the most preferred it is by no means the only angle through which the tynes may be folded. A range between 30° and 120° is preferable. However, folding outside this range still benefits from the advantages of the invention.

In the example shown in Figure 3 each tyne is folded through 45°. However, one tyne could remain unfolded where the other would be bent through twice the angle, that is 90°. Again, this angle is not to be considered as a limiting example.

As shown in Figure 1, a slot 25 extends along the centre portions of the tynes, 20, 22 and terminates at the base of the beam in an aperture 30. The aperture is generally circular. At the free ends

of the tynes, 20, 22 lugs 32, 34 are formed. The width of the tynes at the lugs is slightly greater and the inner edges of the tynes are cut away to define the lugs and also to define guide surfaces 36, 38 which guide a wire as it is inserted into the narrow slot 25.

The contact 10 is first formed as a flat strip into which the apertures 24 and 30 and slots 26 and 25 are formed. Then, the upper tynes are folded around the axis 40 of slot 25 which is the centre axis of the upper beam. As mentioned previously, it is preferred that the folding angle is 45° for each tyne.

Slot 25 is relatively wide before folding. A relatively wide slot is one which is not sufficiently narrow to ensure removal of insulation material from the smallest wire which must fit into the connector. However, once the tynes have been folded through the required angle the width of the inner surface of the slot to be decreased such that it can cut the insulation of the smallest wires which are intended to be received into the contact. Moreover, the cutting is performed by cutting surfaces 46 and 44 (Figures 2 and 3) which present a sharp knife edge to the insulation. In the comparable prior art described above, cutting is performed by inner faces 48 and 50.

The folding of the tynes around axis 40 enables tynes of greater width to be used than in the prior art without an increase in the cross-sectional width of the contact. The increase in width leads to an increase in stiffness which in turn enables longer tynes to be used such that two wires can be inserted between the tynes.

Figures 3a) and 3b) show schematically how the contact functions. The contact shown in these figures is not intended to show all the features of Figures 1 to 3 but is illustrative of function only. Thus, the lugs 32, 34 for example are not shown.

Because each of the tynes are secured at their open ends and the contact is gripped, insertion of a wire causes the contact to bow out and deform elastically in a barrel shape. In other words, although the contact is a V shaped split beam it behaves as a split cylinder. As can be seen from figure 3b) one advantage of this is that two wires can be inserted into the same contact allowing daisy chaining. This is not possible in normal V shaped contacts where the ends are forced apart by the first wire.

Referring back to Figures 1 to 3 it will be seen that the lugs extend beyond the sides of tynes in a direction perpendicular to the axis of the slot 25. This enables the tynes to bow out when the contact is held rigidly in a housing as there is a gap between the housing wall and the sides of the tynes beneath the lugs 32, 34.

Referring now to Figures 4 to 6, the connecting block is a single piece moulding with apertures 60 for receiving the insulation displacement contact. These apertures extend through the connecting block such that the open end of the upper cantilevered beam 17 is accessible in between teeth 62 at the top of the connector block and the lower cantilevered beam is partially shielded by flanges 64, 66 which depend from the body of the connecting block. In position, the open ends of the lower cantilevered beam extend proud of the bottom of the flanges. It should be understood that the insulation displacement contacts are not shown in Figures 4 to 6.

The connector of Figures 4 to 6 is suitable for receiving four insulation displacement contacts. However, the number is immaterial and the block may be made to receive as many IDC's as is required.

The design of connecting blocks is well documented in the art, for example in US 4964812 and US 3798587 referred to previously and both herein incorporated in their entirety by reference. Further description will only be given in respect of novel features.

To enable the barrel shaped opening of the IDC 10, the lugs at the free end of the upper cantilevered beam 19 must be prevented from moving outwards when a wire is inserted into the contact. This is achieved by means of a retaining wall 70 on the internal face of each connector block tooth 62. A wall of each tooth facing one of the openings into which wires are inserted into a respective IDC carries a retaining wall 70. An example of the wall is shown in Figure 5. The wall comprises a protruding portion which extends around the periphery of the tooth such that it surrounds the lugs of the respective IDC which is shown in partial outline in Figure 5. Thus, when a wire is inserted into the IDC, the tynes are restrained from deforming in their natural V-shape and forced to deform in a barrel shape.

Figure 6 shows how the IDC's are arranged in the connecting block for maximum density and minimum block dimensions. The IDC's are arranged along the central axis 72 but with the folded tynes alternately extending on opposite sides of the centre axis 72. The insulation displacement contact described and the connector block within which it is located have a number of advantages over the prior art as discussed herein. In particular, the IDC is easy to manufacture and can be mounted in a very compact connecting block. Moreover, the use of a folding tyne arrangement enables a single IDC to be lengthened to receive two wires which further increases compactness. The combination of the lugs on the tynes and the retaining wall on the teeth of the connector housing obviates the need

for a secondary contact retention device such as is required in the arrangements of US 4964812 and US 3798587.

Figure 7 shows an alternate embodiment of the connecting block in which the width of the end wall of the block is reduced on the side of the central axis 72 opposite to the side on which the folded tynes of the adjacent IDC extend. Thus, in Figure 7 wall portion 80 of end wall 82 is of reduced thickness and wall portion 84 of end wall 86 is of reduced thickness. The reduced thickness portions are on opposite sides of the central axis 72 and form a stepped end wall. Adjacent end block may be arranged side by side as shown in Figure 8 with the overall thickness of the abutting end walls sufficiently small for the blocks to be received side by side on a wiring block.

The arrangement described with respect to Figures 7 and 8 overcomes the problems with inadequate end wall strength encountered in the prior art by providing strength on the side of the central axis to which the end IDC is orientated. This solution requires that blocks have an even number of contacts.

The arrangement also obviates the need to space the contacts irregularly as is outlined in US 4964812 and provides a simple, easy to manufacture housing.

In the embodiment of Figure 9, the teeth 90 have been adapted to allow wires to be inserted by any commercially available wiring tool.

Wiring tools are well known and insert wires in the contact forks and then cut off the excess length. In the United Kingdom, the most commonly available wire inserters are manufactured and sold by British Telecom Plc and AT & T Corp. Neither tool will insert wires in connectors of the other manufacturer, as a consequence of which an installer must carry two wire insertion tools.

The embodiment illustrated is suitable for both tools. The forks of the insulation displacement contacts are located in slots 92 between the faces of the teeth 90. The outside walls of the teeth are provided with a step such that each tooth has a wide castellation portion 94 and a narrow castellation 96. The wide castellation is suitable for locating the British Telecom tool whereas the narrow castellation is suitable for the AT & T tool.

In the embodiment illustrated, the steps are shown on one face of the connector. An alternative embodiment provides steps on both faces. The steps could be on alternate sides of the connector such that the step for one tooth is on the opposite side of the connector to the steps on the immediately adjacent teeth.

The embodiment described has the advantage of flexibility as the vast majority of wiring tools may be used to insert wires into it. This reduces the equipment needed by the installer and may reduce installation time.

The embodiment of Figure 9, and its alternative may be used, for example, with any of the embodiments described previously although not shown in Figure 9, the contacts are preferably those shown in Figures 1 to 3 and arranged as shown in Figure 5.

Attention is directed to our parent application EP-A-0588834 and to our divisional application EP94 which claim other aspects of the connector described herein.

Claims

1. An insulation displacement connector comprising a plurality of insulation displacement contacts (10), and a housing, the contacts being received in shaped apertures (60) in the housing and comprising first and second contact portions (14, 17), the second contact portions being arranged to receive insulated wires and comprising a cantilevered beam (19) split into first and second tynes (20, 22) by a slot (25) extending along an axis of the beam, at least one tyne being folded about the slot axis, the shaped apertures in the housing being arranged along a central axis (72) of the housing to receive the contacts (10) with the folded at least one tyne of alternate contacts extending on opposite sides of the central axis.

2. A insulation displacement connector according to Claim 1, wherein the housing further comprises a plurality of teeth (90) disposed on either side of the tynes and each having a retaining wall for receiving lugs (32, 34) on the free ends of the tynes to limit displacement of the tynes on insertion of a wire therebetween.

3. An insulation displacement connector according to Claim 1 or 2, wherein each contact is received in a respective aperture in the housing, the housing having a plurality of teeth (90) on each side of the apertures to shield the contacts, the teeth (90) each having a stepped outer face, adjacent teeth defining relatively wide (94) and narrow (96) castellations for receiving wire inserter tools.

4. An insulation displacement connector according to Claim 3, wherein an outer face of each tooth has a recess (94) extending along the length of the tooth at each side of the face, the recesses of each tooth defining the relatively narrow castellations therebetween.

5. An insulation displacement connector according to Claim 3 or 4, wherein the relatively wide castellations are provided on a first side of the housing and the relatively narrow castellations on an opposite side of the housing.

6. An insulation displacement connector according to any one of Claims 1 to 5, wherein the insulation displacements contacts are received in the housing at a substantially constant pitch along an axis, the housing comprising end walls (82, 86) having a stepped profile, the thickness of each end wall varying along the wall to define a relatively thin portion (80, 84) on one side of the axis and a relatively thick portion on the other side of the axis.

7. An insulation displacement connector according to Claim 6, wherein the housing comprises a first and a second end wall (82, 86), the profile of the first end wall being the inverse of the profile of the second end wall, whereby two or more housings are stackable end to end with a constant insulation displacement contact pitch.

Fig.1

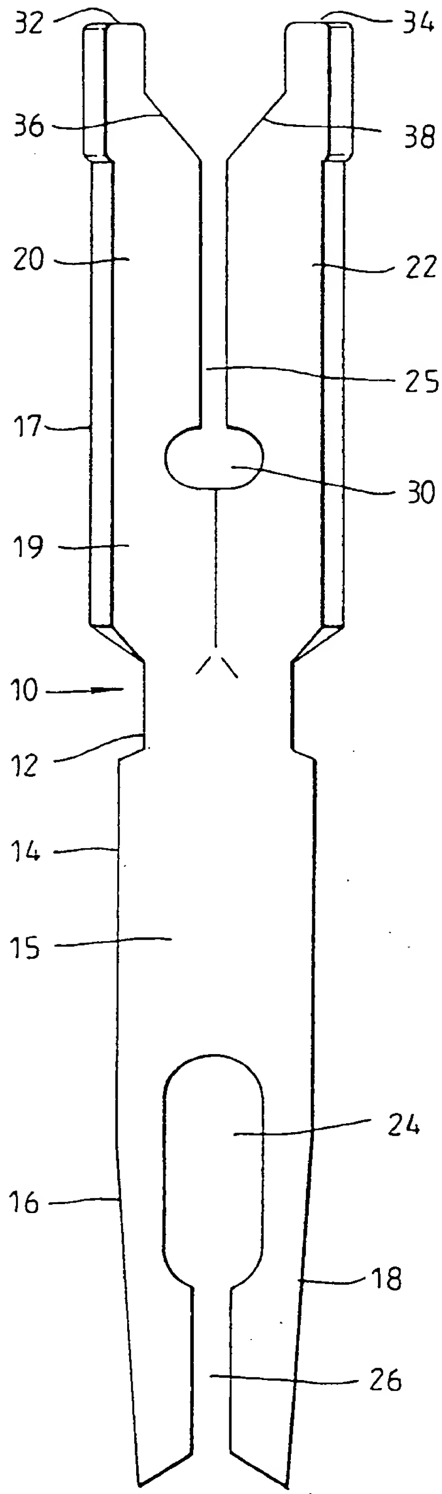


Fig.3

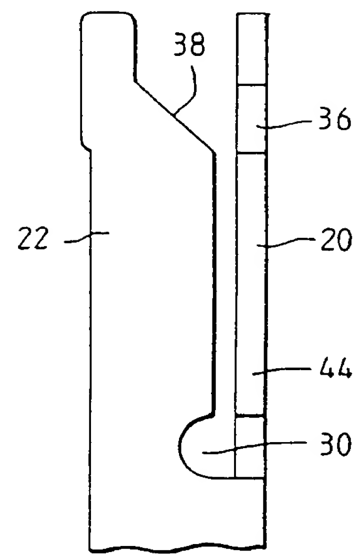


Fig.2

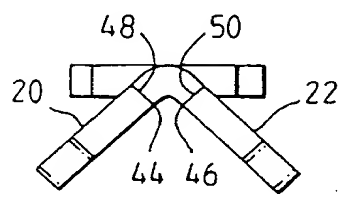


Fig.3(a)

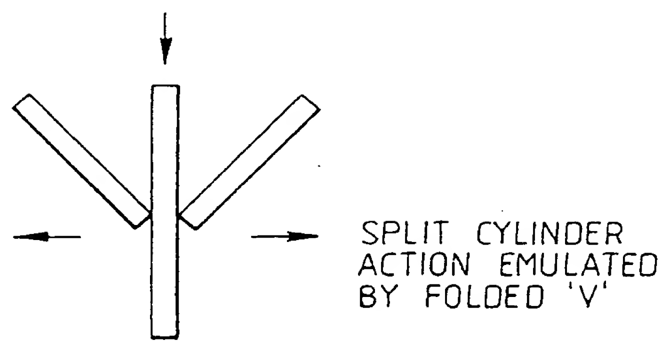


Fig.3(b)

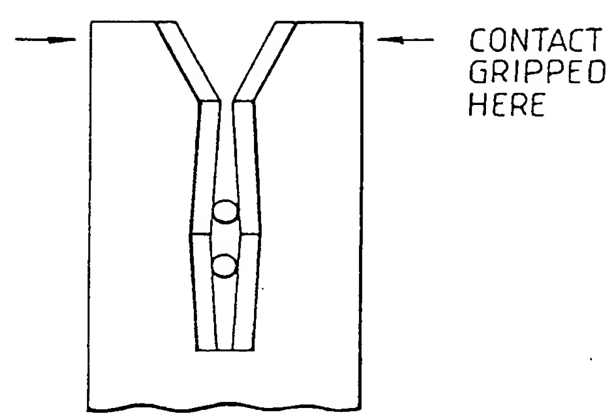


Fig. 4

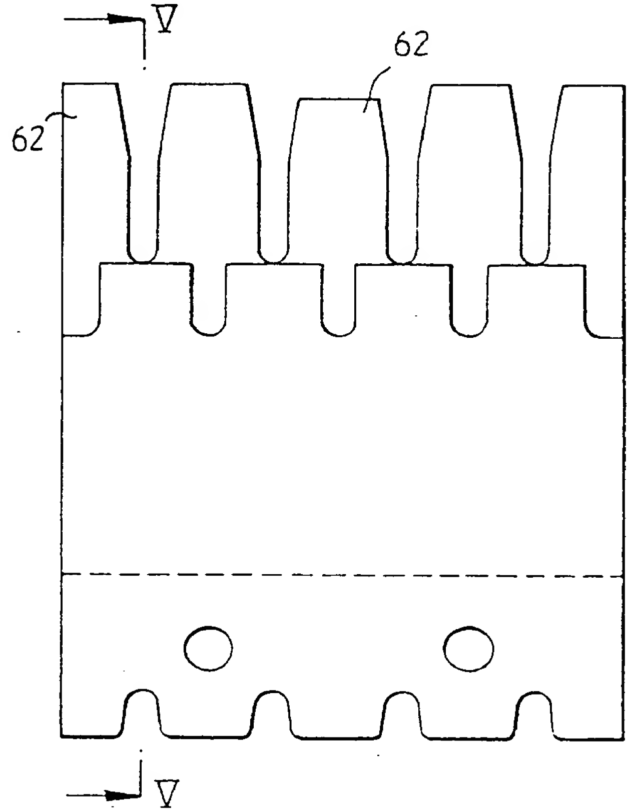


Fig. 5

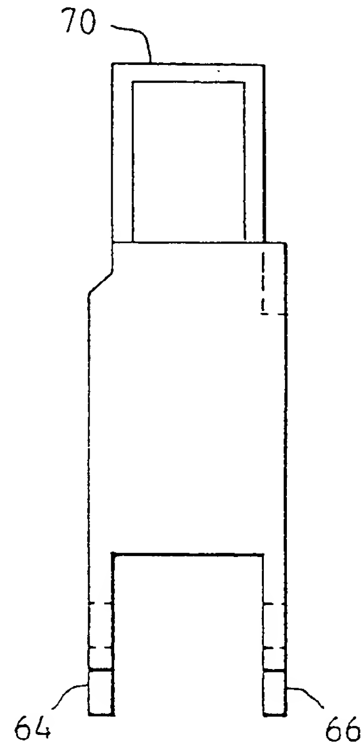


Fig. 6

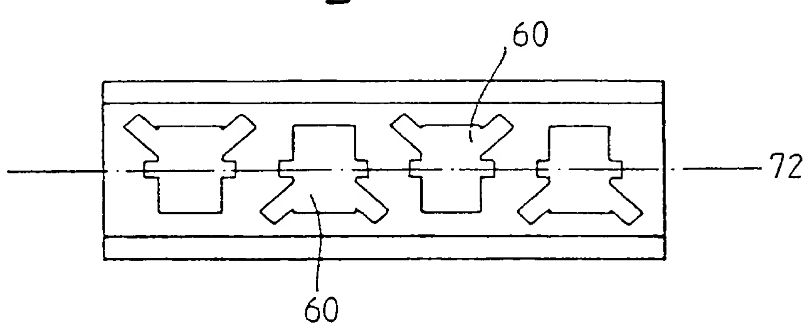


Fig.7

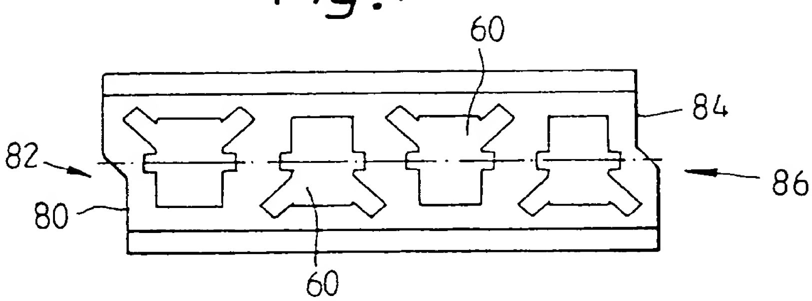


Fig.8

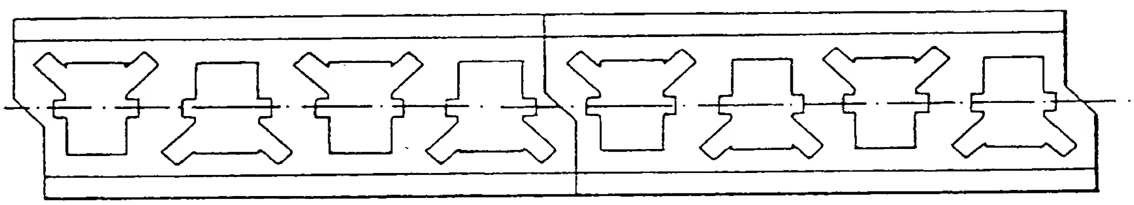
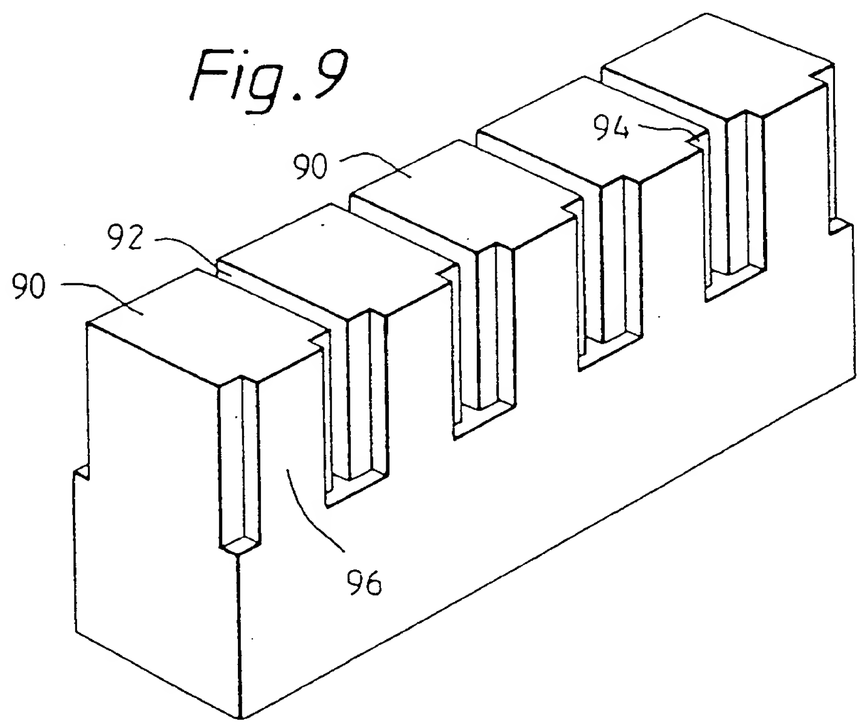


Fig.9



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 643 440 A3

(12) # EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
29.05.1996 Bulletin 1996/22

(43) Date of publication A2:
15.03.1995 Bulletin 1995/11

(21) Application number: 94203444.8

(22) Date of filing: 03.06.1992

(51) Int. Cl.^{6}: **H01R 4/24**, H01R 9/24

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU MC NL SE

(30) Priority: 12.06.1991 GB 9112604
05.07.1991 GB 9115020

(62) Application number of the earlier application in accordance with Art. 76 EPC: 92911028.6

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(54) **Electrical connectors**

(57) An insulation displacement contact (10) comprises first and second contact portions each of which comprises a cantilevered split beam (19). The upper split beam, which receives insulated wires, comprises a pair of tynes (20,22) which are folded about the axis of a slot (25) separating the tynes such that the internal angle between the tynes is approximately 90°. The width of the tynes is larger than that of prior art devices resulting in increased stiffness and the length of the tynes is sufficiently long to receive two wires therebetween.

The contacts (10) are mounted in a housing which includes a plurality of teeth (90) provided with means for retaining lugs (32,34) on the end of the tynes to ensure bowed opening of the tynes on insertion of a wire. The contacts are arranged along the central axis (72) of the housing such that the folded tynes of alternate contacts extend on opposite sides of the central axis.

Fig.1

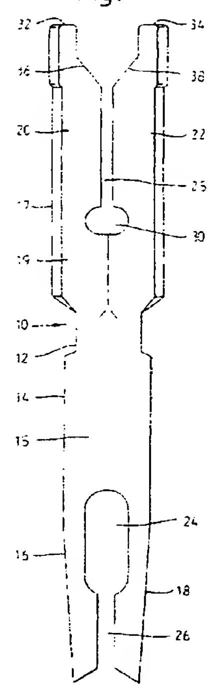

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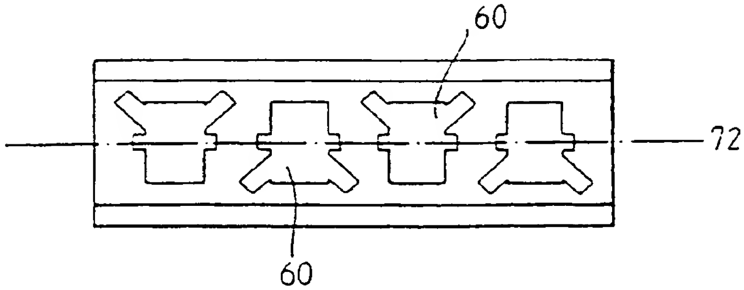
Fig. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 3444

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
D,A	GB-A-2 112 217 (BROOMADIT LIMITED) * page 1, line 103 - page 2, line 11; figures 2,3 *	1	H01R4/24 H01R9/24
A	EP-A-0 124 721 (KRONE GMBH) * page 4, line 18 - line 21; figure 4 *	1	
A	US-A-3 702 983 (CHACE ET AL.) * figure 3 *	1	
A	FR-A-2 269 799 (ETABLISSEMENTS HENRI POUYET A.C.E.T.P.) * figure 5 *	3,4	
A	US-A-2 984 817 (ZEFFERT) * column 2, line 12 - line 16; figure 2 *	6,7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 March 1996	Kohler, J

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)